The **M**idwest **A**erosol **P**roduction **Ex**periment **- MAPEx**

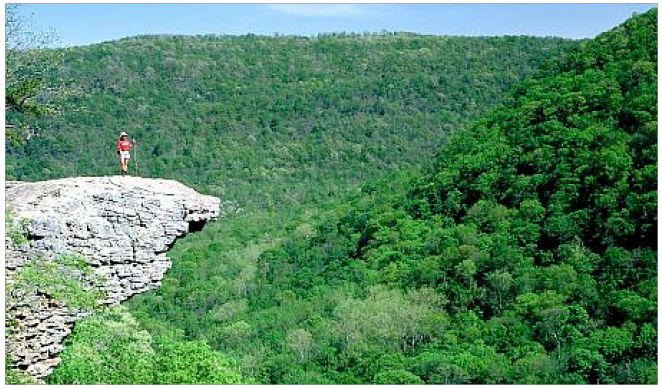
Paul V. Doskey, Richard E. Honrath, Claudio Mazzoleni, Lynn R. Mazzoleni, Judith A. Perlinger, Noel R. Urban, Shiliang Wu

Atmospheric Sciences Program
Michigan Technological University

Field Campaign Objective

- To rigorously evaluate the production and radiative forcing properties of secondary inorganic and organic aerosol (SIA, SOA) from a wide variety of aerosol precursors.

The Ozarks

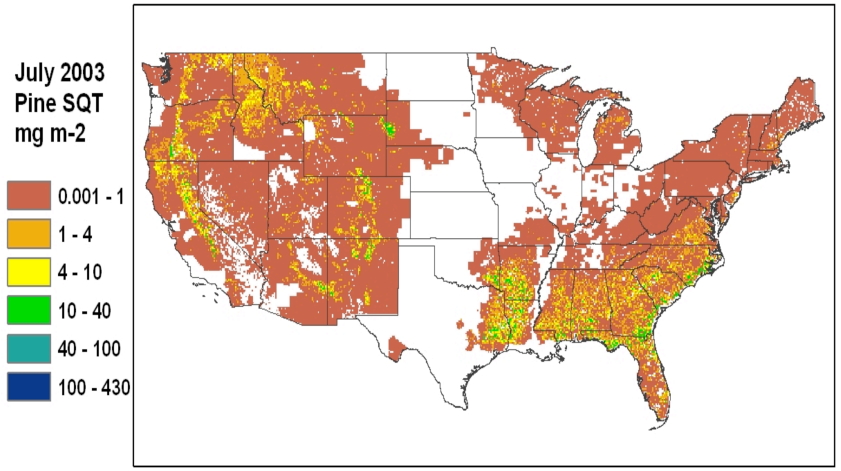


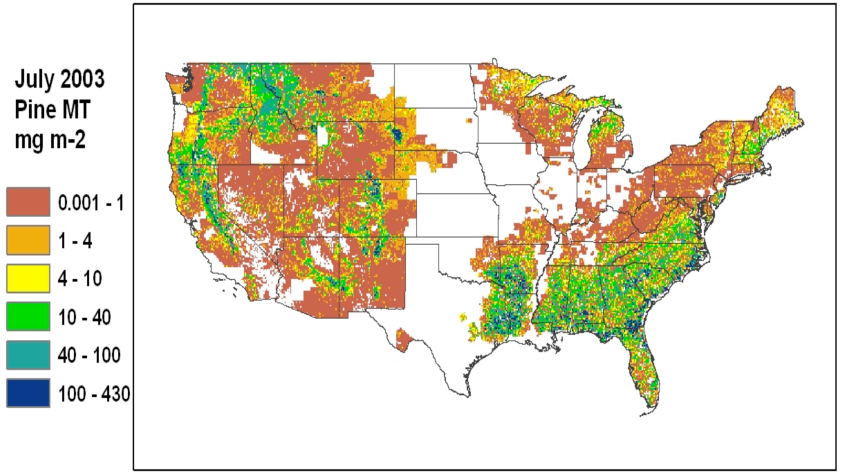
St. Louis, MO

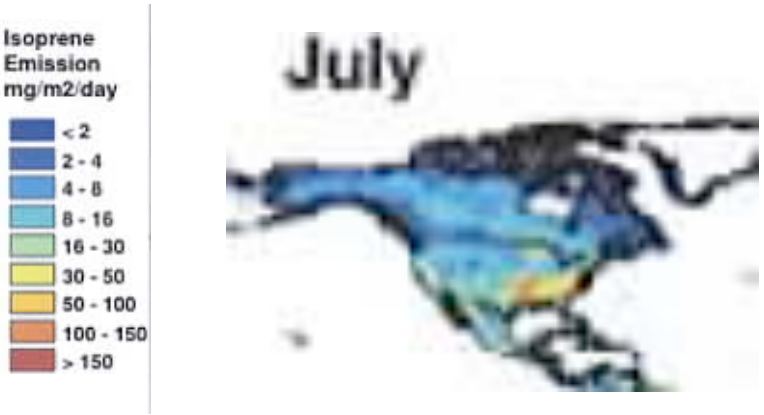
Agriculture

Emissions of Biogenic SOA Precursors From The Ozarks

The Ozarks region is a rich source of isoprene, monoterpenes, and sesquiterpenes.



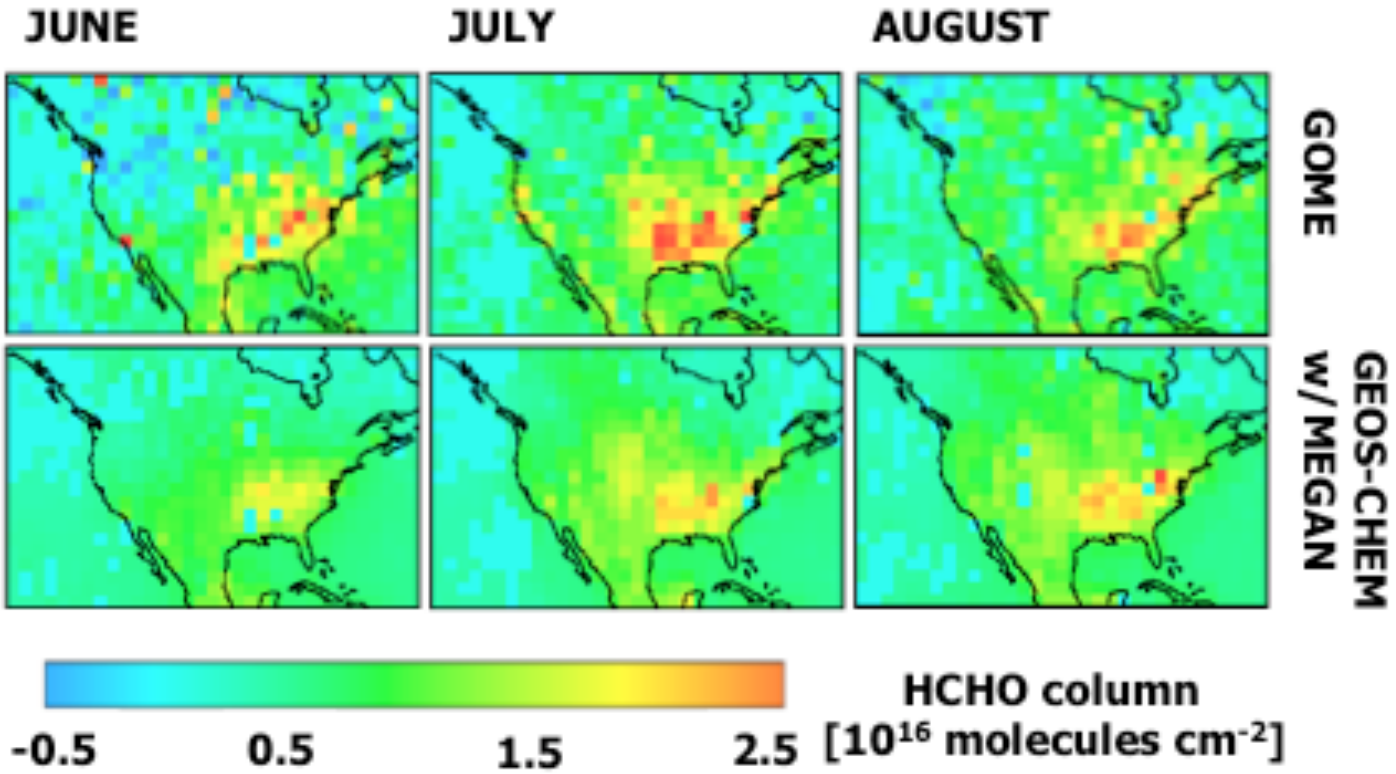




Guenther et al., *Atmos. Chem. Phys., 6*, 3181-3210, 2006.

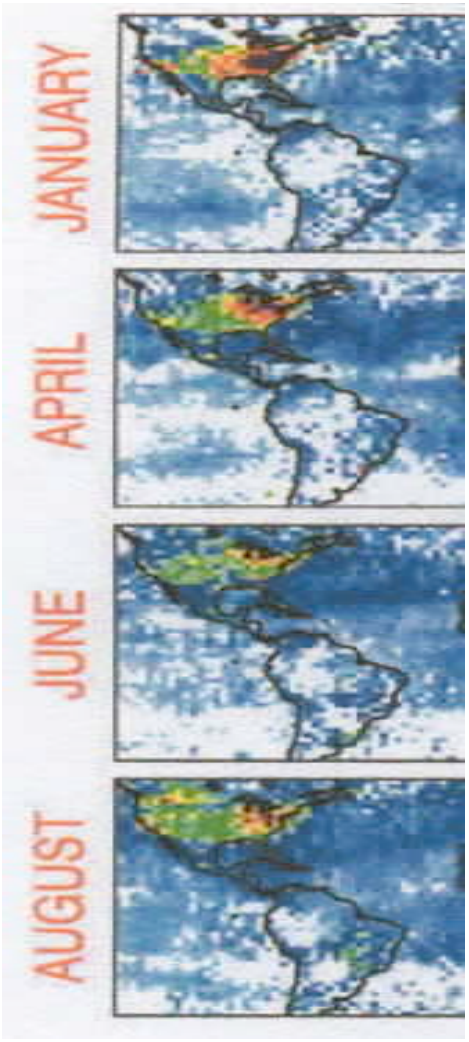
A Region of High Photochemical Activity

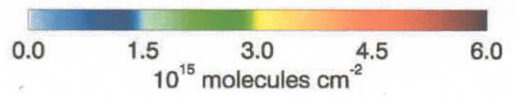
Monthly Mean Column HCHO Over
North America



Guenther et al., *Atmos. Chem. Phys., 6*, 3181-3210, 2006.

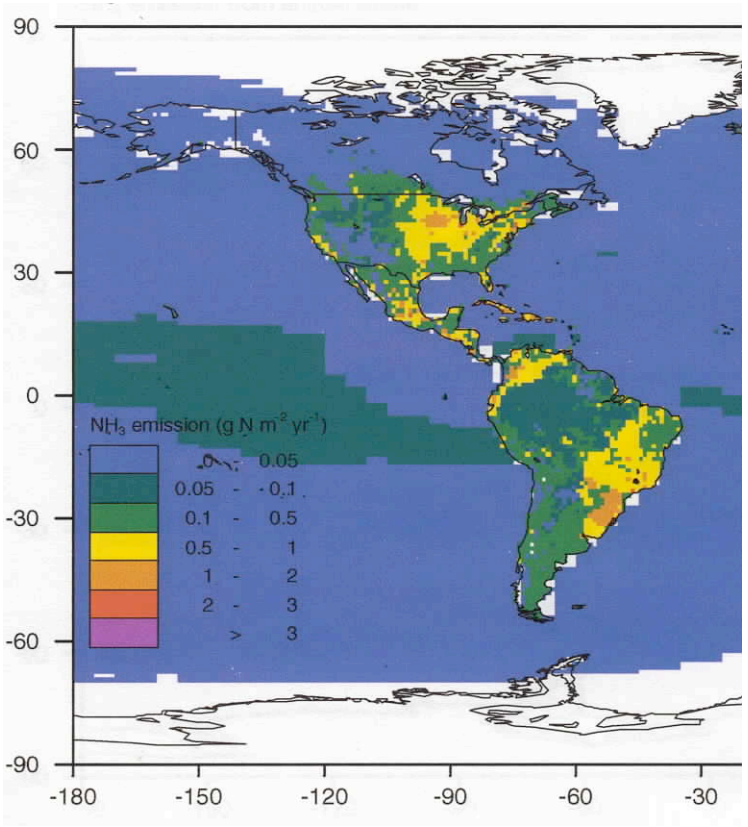
Emissions of SIA Precursors from Agricultural Soils





GOME observations of column NO_2

Jaeglé et al., *Faraday Discuss., 130*, 407-423, 2005.



Estimated NH_3 emissions from all sources.

Asman, http://nadp.sws.uiuc.edu/nh4ws/, 2003.

- Satellite observations indicate soil-derived NO_x might be 70% greater than earlier predictions.
- Animal waste is the largest source of NH_3 followed by fertilized agricultural fields.

St. Louis, MO

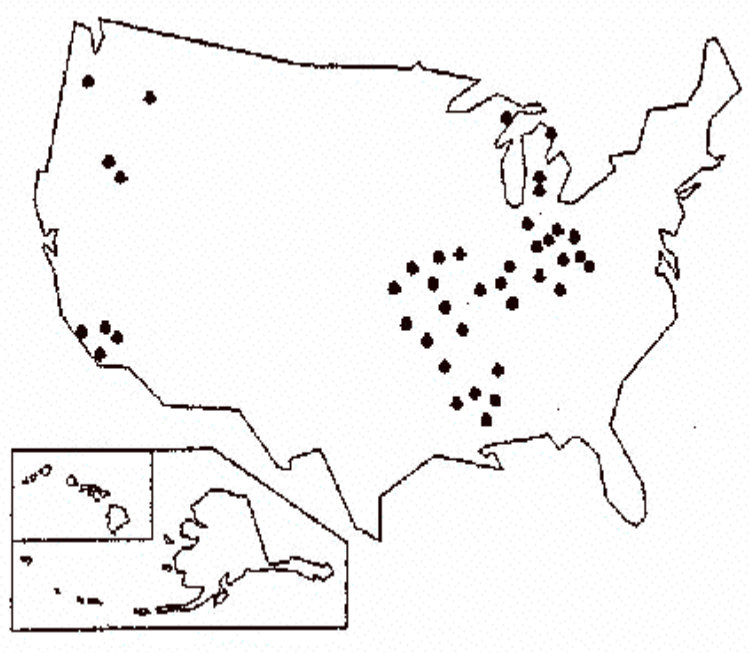
- The 18th largest metropolitan area in the U.S. (pop. 2,801,033).
- Number 10 on the list of unhealthiest commutes in U.S.
- Humid subtropical climate.

Cahokia Power Plant

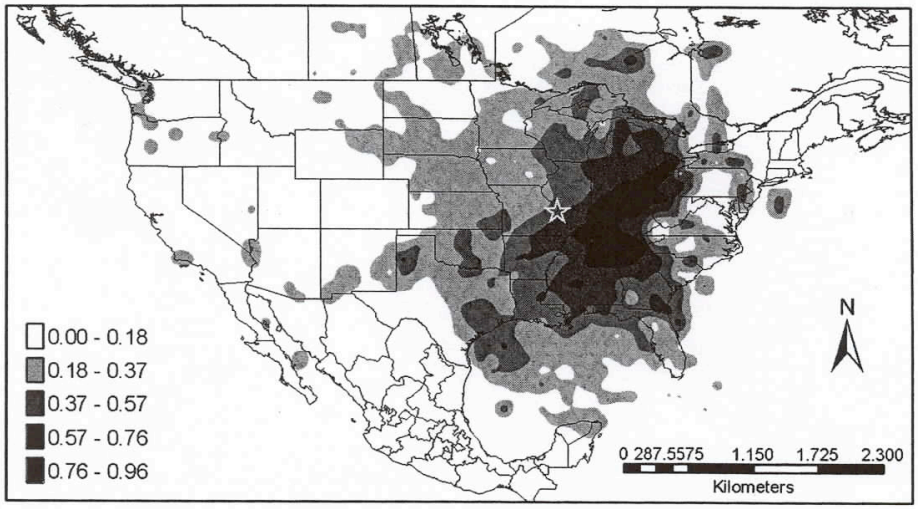
Sulfate Aerosol in St. Louis, MO*

- Sulfate-rich secondary aerosol was likely produced by emissions from coal-fired power plants in the Ohio River Valley.

Distribution of Coal-Burning Power Plants in the United States

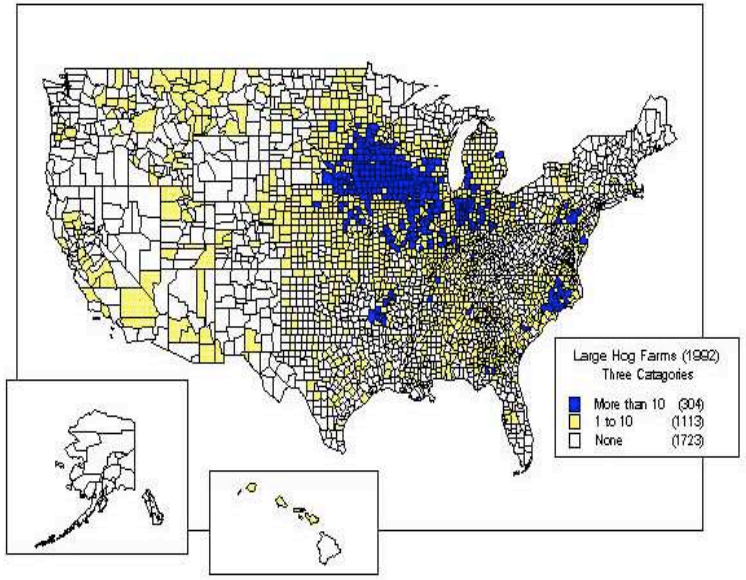


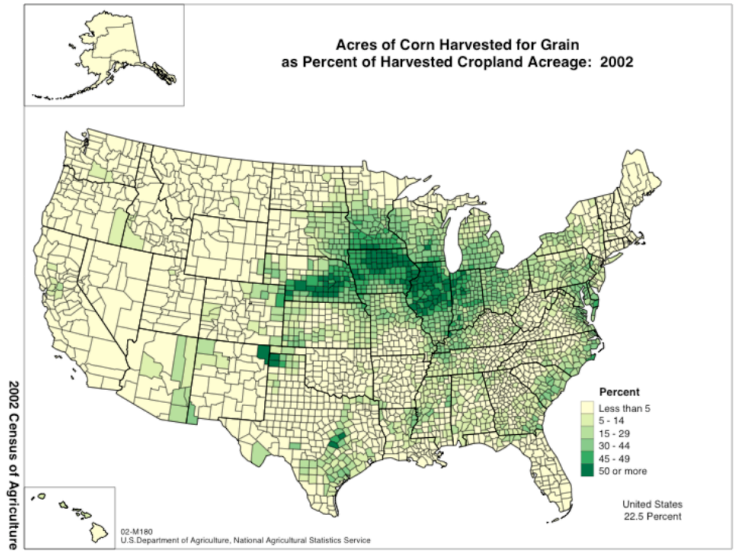
Potential Source Contribution Function (PSCF)



*Lee, J.H. & Hopke, P.K., *Atmos. Environ., 40*, S360-S377, 2006.

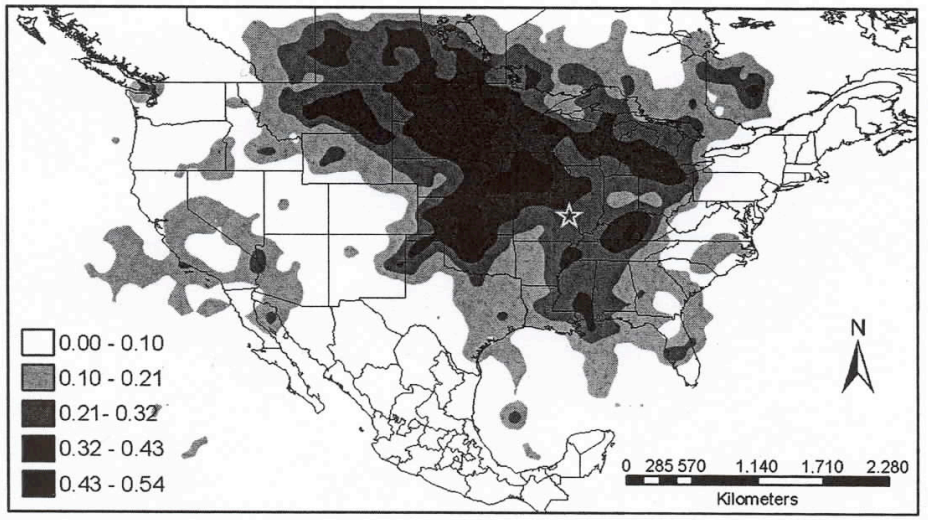
Nitrate Aerosol in St. Louis, MO*





- The contribution of regional ammonium nitrate was estimated to be 63%.

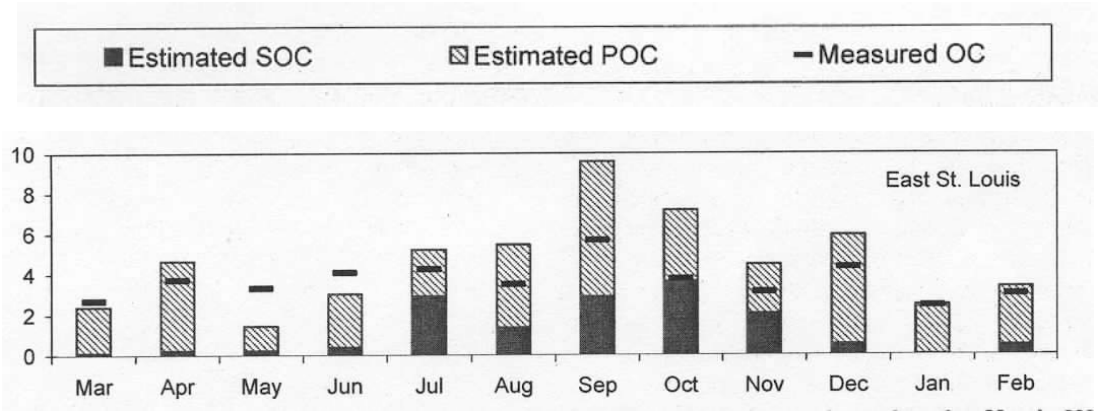
Potential Source Contribution Function (PSCF)

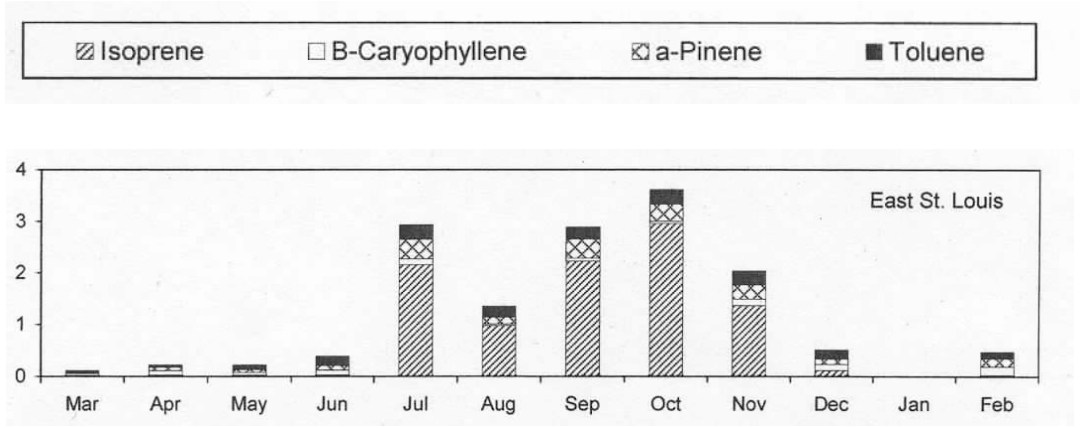


*Lee, J.H. & Hopke, P.K., *Atmos. Environ., 40*, S360-S377, 2006.

SOA From VOCs in St. Louis, MO*

- Estimated contributions of SOA to the measured organic carbon during July are about 60% with 70% originating from isoprene.

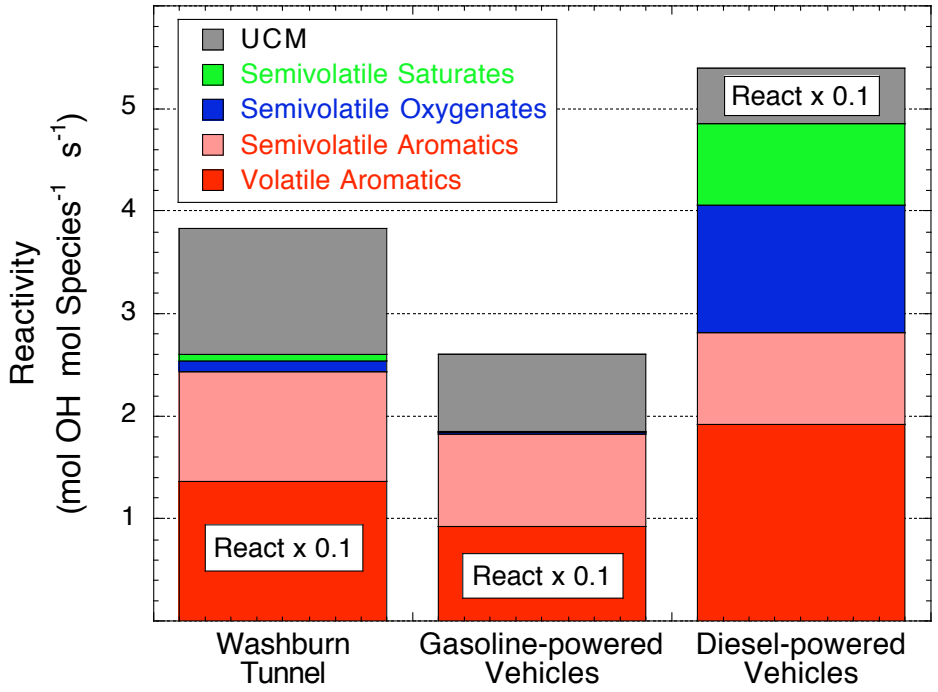




*Lewandowski et al., *Environ. Sci. Technol.,42*, 3303-3309, 2008.

SOA From SVOCs in St. Louis, MO

- $PM_{2.5}$ attributed to GPVs and DPVs in St. Louis was estimated to be 21% and 5%, respectively.
- ~15% of SOA precursor emissions in a Houston Washburn Tunnel sample with 6% DPVs is attributed to SVOCs*.
- SVOCs from DPV might be responsible for ~15% of SOA in St. Louis.



*Doskey, *Geophys. Res. Lett., submitted*, 2009.

Wide Variety of Aerosol Precursors

The Ozarks

Isoprene
Monoterpenes
Sesquiterpenes

St. Louis

SO_x, NO_x, NH_3
Monoaromatics
Semivolatile aliphatics, oxygenates, polyaromatics

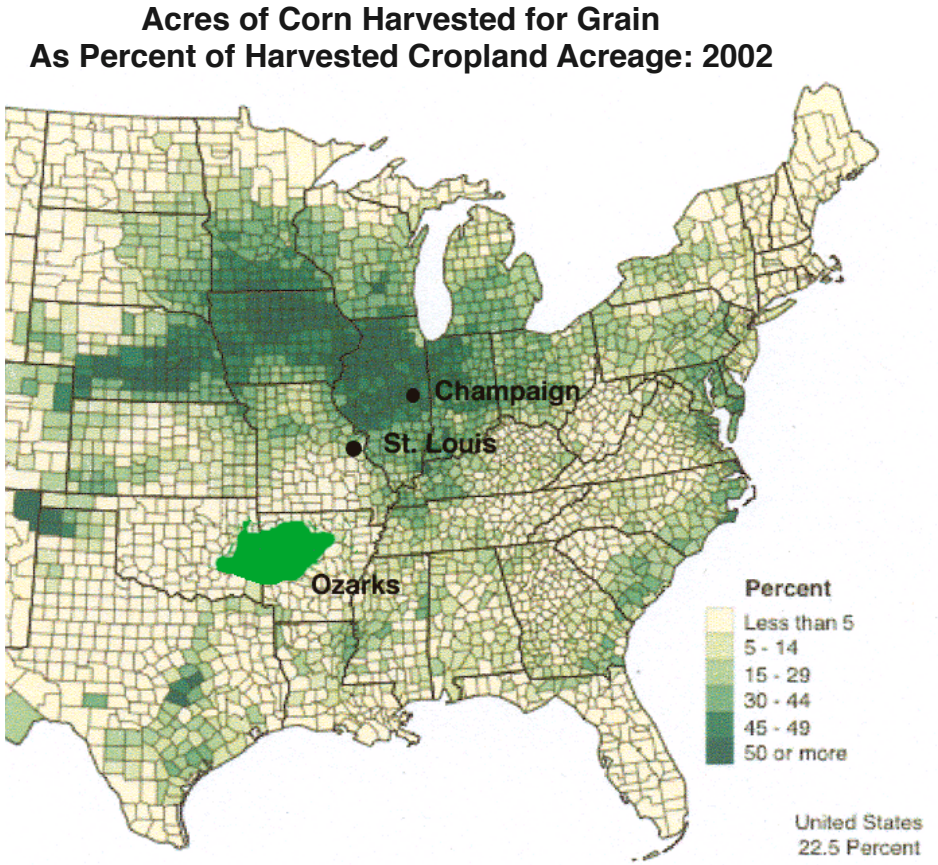
Agriculture

NO_x, $NH_{3,}$ Amines
Sesquiterpenes

Geographic Domain of MAPEx

Surface Sites

- St. Louis, MO - USEPA Midwest Supersite
- Champaign, IL - ISWS Bondville Environmental and Atmospheric Research Site (BEARS)
- Savoy, IL - NH_3 flux measurements



Key Science Questions

- How is SOA yield in forested, urban, and agricultural areas affected by gas-phase oxidants, primary organic aerosol (POA), particle acidity associated with SIA, temperature, and relative humidity?
- What fraction of SOA in urban areas is contributed by semivolatile organic compound (SVOC) precursors?
- Does gas/aerosol partitioning of photooxidized SVOCs enhance uptake of SOA derived from terpenes and monoaromatics?
- What are the contributions of carboxyllic acids and organonitrates to SOA? and relative to SIA, do they significantly affect aerosol hygroscopicity, CCN activation, and optical properties?
- What fraction of SOA in agricultural areas is contributed by sesquiterpene emissions?
- What role do amines play in new particle formation?
- Do organonitrate aerosol yields increase in agricultural areas?
- Can aircraft observations be used to verify emission inventories of NH_3, NO_x, and N_2O from agricultural soils?

Participants

Charles L. Walthall, National Program Leader
Climate Change, Soils and Emissions Research Program
USDA-ARS

Alex Guenther, Senior Scientist
Atmospheric Chemistry Division
National Center for Atmospheric Research
Tower and Airborne VOC Flux Measurements in the Ozarks

Paul V. Doskey (MTU) and John T. Walker (USEPA-RTP)
AGU Special Session Organizers